

VU Research Portal

The role of different directions of attention on the extent of implicit perception in soccer penalty kicking

Memmert, Daniel; Noël, Benjamin; Machlitt, Daniel; van der Kamp, John; Weigelt, Matthias

published in

Human Movement Science
2020

DOI (link to publisher)

[10.1016/j.humov.2020.102586](https://doi.org/10.1016/j.humov.2020.102586)

document version

Publisher's PDF, also known as Version of record

document license

Article 25fa Dutch Copyright Act

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Memmert, D., Noël, B., Machlitt, D., van der Kamp, J., & Weigelt, M. (2020). The role of different directions of attention on the extent of implicit perception in soccer penalty kicking. *Human Movement Science*, 70, 1-9. [102586]. <https://doi.org/10.1016/j.humov.2020.102586>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl



Full Length Article

The role of different directions of attention on the extent of implicit perception in soccer penalty kicking



Daniel Memmert^{a,*}, Benjamin Noël^a, Daniel Machlitt^c, John van der Kamp^{d,e},
Matthias Weigelt^b

^a German Sports University Cologne, Germany

^b University of Paderborn, Paderborn, Germany

^c Bielefeld University, Germany

^d VU University Amsterdam, The Netherlands

^e University of Hong Kong, Hong Kong

ARTICLE INFO

Keywords:

Implicit perception

Off-center effect

Action selection

Sports performance

Soccer penalty kick

ABSTRACT

The role of different directions of attention on the extent of the off-center effect (penalty takers kick to the bigger side of the goal more often, although they explicitly perceive the goalkeeper in the center of the goal) was investigated for soccer penalty kicking. Regarding the directions of attention of the striker, two conflicting assumptions (attention is paid to the goalkeeper vs. attention is only spent on target) were directly contrasted. Participants viewed a goalkeeper standing either in the middle of the goal or being displaced by different distances to the left or right. In the goal-side-related instruction condition, participants had to indicate the greater goal side and already did so at above chance-level for small displacements of 0.1%, although they were not confident in their perceptual judgments, hinting at the occurrence of the off-center effect. They became mindful of displacements of 0.8% and larger when they indicated the goal side for kicking with greater confidence. In the goalkeeper-related instruction condition, participants were asked to choose a goal side for kicking, but only when they perceived the goalkeeper in the middle of the goal. Participants chose the greater goal side at above chance-level for small displacements of 0.2%. They became mindful of the displacement for a difference of 0.8%. However, when comparing the results of both instruction conditions statistically it turned out that the effect of different directions of attention on the off-center's extent differs from those previously reported. Participants were implicitly influenced by comparably small goalkeeper displacements, but became earlier aware of goalkeeper displacements in the goal-side-related instruction condition.

The off-center effect in soccer penalty kicking implies that the goalkeeper's position on the goal line relative to the goal's center can affect decision-making of a penalty taker, even if the kicker is not aware of the goalkeeper's displacement: Penalty takers choose to kick the ball to the side opposite to where the goalkeeper is displaced to (usually about 60% of all penalty kicks), although they do not believe that one side is smaller than the other. This off-center effect on goal-side selection has been demonstrated several previous studies (e.g., Masters, van der Kamp, & Jackson, 2007; Noël, van der Kamp, Weigelt, & Memmert, 2015; Weigelt & Memmert, 2012; Weigelt, Memmert, & Schack, 2012). However, these previous studies are lacking in consistency concerning methods, definitions, participants' instructions, and overall results. Therefore, we investigated different directions of attention of the participants using the

* Corresponding author.

E-mail address: memmert@dshts-koeln.de (D. Memmert).

<https://doi.org/10.1016/j.humov.2020.102586>

Received 5 August 2019; Received in revised form 17 December 2019; Accepted 15 January 2020

Available online 29 January 2020

0167-9457/ © 2020 Published by Elsevier B.V.

established lab-based off-center paradigm, because of the possibility of presenting conditions with very small displacements of the goalkeeper.

Consider, for example, the series of three experiments in the original study by Masters et al. (2007). Participants were shown pictures of a filled block (Experiment 1) or a real goalkeeper (Experiment 2) located on the goal line at 14 different displacements to the left or right of the exact middle of the goal. Participants were instructed to select the goal side with the greater area (*goal-side-related direction of attention*). Although they reported low confidence in their perceptual judgments at differences in an area as small as 0.5% (i.e., they felt they were simply guessing), they were still able to indicate the greater side of the goal at above-chance level. In Experiment 3, the authors altered the instructions: Participants were now told to only kick if they perceived the goalkeeper to be standing exactly in the middle of the goal (*goalkeeper-related direction of attention*). Importantly, no allusions were made to the size of the goal areas to the left and right of the goalkeeper. That is, from the participants' perspective, it did not make sense to attend to the goalkeeper position, respectively the sizes of the two goal-sides, after the decision to kick had been made, because they were instructed to only kick when they perceived the goalkeeper in the middle of the goal (i.e. both goal sides were of equal size to the participants) (for a comparable argument in a beach volleyball scenario see Noël, Hüttermann, van der Kamp, & Memmert, 2016). It was found that participants kicked the ball for small goalkeeper displacements, indicating that they were not consciously aware of the fact that the goalkeeper was displaced, standing marginally off-center. Yet, at displacements of the goalkeeper between 1.6% and 3.0% participants directed the ball to the side with the greater area at above chance-level. Together, the three experiments by Masters et al. (2007) and those of other authors (Noël, van der Kamp, et al., 2015; Weigelt et al., 2012; Weigelt & Memmert, 2012) provided evidence for the influence of implicit perception on the decision-making process of penalty takers (as signified by the off-center effect).

Importantly, the off-center effect occurred in these previous studies irrespective of whether the participant's attention was directed to the sizes of the two goal-sides (goal-side-related direction of attention) or the position of the goalkeeper (goalkeeper-related direction of attention). At the same time, it is not known if these different types of directions of attention also result in different processing of the stimulus features and thus, to differences in the allocation of attentional resources in the kicker. In this regard, Noël et al. (2016) argued that participants' attention may be directed to the goalkeeper and his relative position on the goal line (alternatively to the sizes of the areas to the left and right of the goalkeeper), when being asked to always kick to the bigger side of the goal, whereas attention in the other instruction condition seems to be directed to other stimulus features (e.g., goalkeeper related stimuli except his position). When participants first have to decide on the position of the goalkeeper they clearly have to attend to him and his relative position on the goal line. But, importantly, afterward – when deciding where to kick – there is no need and no reason to attend to the displacement of the goalkeeper, because he was just perceived to be in the center of the goal. Such differences in the allocation of attention could indeed result in different displacements being perceived or not, which may be attributed to different modes of processing (subliminal vs. preconscious processing), according to the taxonomy of Dehaene, Changeaux, Naccache, Sackur, and Sergent (2006).

Concerning directing the focus of attention of the striker, different research lines and results exist in the literature (for a review, Memmert, Hüttermann, Hagemann, Loffing, & Strauß, 2013). On the one hand, recent studies suggest that the penalty taker should set his shot target in advance – before kicking the penalty (Noël, Furley, van der Kamp, Dicks, & Memmert, 2015; Noël & van der Kamp, 2006; Harle & Vickers, 2001; Noël, & van der Kamp, 2012; Vickers, 2012; Wood & Wilson, 2011; Wood & Wilson, 2012). Therefore, it is better to choose a goal side before shooting and not to pay much attention to the goalkeeper. In this case, the kicker has a focused view on the target (one side of the goal) when executing the shot. Thus, no attention is directed at the goalkeeper, but only on the target.

On the other hand, strikers could pay attention to the goalkeeper to anticipate the direction of his/her movement. Should the goalkeeper draw the shooter's attention to himself? Several investigations support the idea that penalty takers should avoid paying attention to the goalkeeper, because of distracting information (Bakker, Oudejans, Binsch, & van der Kamp, 2006; Binsch, Oudejans, Bakker, & Savelsbergh, 2010; Furley, Noël, & Memmert, 2017; Wilson, Chattington, Marple-Horvat, & Smith, 2007). Thus, does the kicker have an advantage by paying much attention to the goalkeeper? In this case, attention is directed to the goalkeeper and less on the target. To build our investigation on existing research, the experimental design we used is similar to one that has already been conducted by Masters et al. (2007). Therefore, our experiment will use the same static display in a lab environment. Using the same set-up as Masters et al. (2007), we are able to test whether different instructions that affect the direction of attention influence the extent of the off-center effect. Also, based on previous research (Weigelt et al., 2012; Weigelt & Memmert, 2012), we assume that different directions of attention will only lead to small off-center effects. Consequently, we need extremely small displacements in our experiment. Therefore, we cannot use ecological valid stimuli (e.g., position of a real goalkeeper on the pitch) as Noël, van der Kamp, et al. (2015) did. Besides, it seems to be rather difficult (or even impossible) to move the goalkeeper in cm-steps on a real goal line on the pitch during the experimental procedures.

Before starting to hypothesize about the origin of differences between the results associated with both off-center directions of attention there seems to be a need of comparing results in more detail and scrutinizing if different directions of attention indeed influence the extent of the off-center effect. Recent findings of (Fiedler 2011 see also Simmons et al. 2011) suggested repeating the effects found within one group of participants with other participants to ensure that the phenomenon does not only apply to a certain population, but generalizes towards the behavior or the phenomenon. This is why we aimed to replicate the findings of previous studies on the off-center effect in a first step (using smaller goalkeeper displacements than before to allow more precise estimations), to analyze/compare the results of both direction of attention conditions more directly in a second step. Far more important, we contrast two conflicting hypotheses within the off-center effect paradigm. Is it better to choose a goal side before shooting and not to pay much attention to the goalkeeper (Noël, Furley, et al., 2015) or has it an advantage to pay attention to the goalkeeper (Binsch

et al., 2010)? Therefore, we asked participants to participate in the experiment under two differing attentional conditions and hypothesized that directions of attention will indeed lead to different extents of the off-center effect (i.e., different thresholds of perception).

1. Methods

1.1. Participants

A total of 34 male and female participants (mean age = 23.6 years; ranging from 20 to 27 years) with normal or corrected-to-normal vision took part in this experiment. All participants were sport science students and naïve to the purpose of the present experiment. However, none of the participants was an active soccer player or had extensive practice in this sport. Based on the results of Weigelt and Memmert (2012), who found no effects of expertise levels, this was considered unproblematic. The participants gave their written informed consent before testing and were not paid for their participation. The study was approved by the local ethics committee and was carried out in accordance with the Helsinki Declaration of 1975.

1.2. Apparatus, stimuli, and task conditions

Similar to the set-up used by Weigelt and Memmert (2012) and by Weigelt et al. (2012), pictures of a male goalkeeper in a neutral goalkeeping posture were taken on an outdoor soccer pitch from the kicker's perspective. Using Corel Paint Shop Pro, the goalkeeper was cut out and copied into one of eight positions: Either in the goal's center or displaced by 0.1%, 0.2%, 0.4%, 0.8%, 1.6%, 3.2%, and 6.4% to the left and right of it (see Fig. 1). This resulted in a total of fifteen stimulus images. Accordingly, the displacements of the goalkeeper to the left or right of the center related to 0.73 cm, 1.46 cm, 2.92 cm, 5.85 cm, 11.71 cm, 23.42 cm, and 46.84 cm, when translated to the real-life goal size. These intervals were chosen to have a more precise differentiation concerning the small displacements than Masters et al. (2007), Weigelt and Memmert (2012), and Weigelt et al. (2012) used hoping to identify a lower threshold of implicit perception (demarcating implicit and no perception) more precisely. All pictures were displayed on a 24-in. computer display. The size of each stimulus was 1024×338 pixels, and they were presented in the center of the screen.

The experiment consisted of two conditions of which the order was counterbalanced. The conditions differed in their instructional focus and, therefore, in their induced direction of attention. In the *goal-side-related instruction condition* (cf. Masters et al., 2007, Exp. 1 & 2), participants were asked to indicate the larger goal side (*"Please decide which goal side represents the larger side for kicking."*) by pressing the "Alt"-key for the left goal side and the "Alt Gr"-key for the right goal side on the keyboard. If they felt unsure about which goal side was larger, they were instructed to decide intuitively and follow their first impression. Thus, the responses given are similar to those of typical forced-choice paradigms. In addition, participants had to decide how confident they felt about their choice on a scale from 1 ("not confident at all") to 7 ("very confident") after each trial, using the numbers on the keyboard. In the *goalkeeper-related instruction condition* (cf. Masters et al., 2007, Exp. 3), participants selected one of the two goal-sides only if they perceived the goalkeeper standing in the exact middle of the goal (*"Please decide in which corner of the goal you would kick by pressing the left or right button only if the goalkeeper is placed exactly in the middle of the goal. When the goalkeeper is displaced, continue with pressing the button in the middle."*) Otherwise, they only had to report that the goalkeeper was displaced by pressing the space bar.

1.3. Design and procedure

Participants received written instructions for the task. They started with a practice block, in which each of the fourteen displacements was presented only once, while the zero-displacement was presented three times, totaling in 17 trials (comprising a mini-block), all being presented in random order. The following two conditions of the experiment consisted of 170 trials each (resulting in a total of 340 test trials in four blocks of 85 trials). Each trial started with a blank screen (250 ms) and the stimulus image, which was presented until a response was given. The different stimuli were presented randomly within each block, and participants were allowed to take a short break between them. The whole experiment lasted about one hour.

1.4. Data analyses

The results of the *goal-side-related instruction condition* were analyzed for the 15 different goalkeeper positions. According to the task, the smaller side of the goal was assigned to a value of 0 (wrong decision) and the larger side to a value of 1 (right decision). This way, the probability of choosing the larger side was calculated for each participant and position. Planned comparisons (i.e. one-sample *t*-Tests) against chance level (50%) were conducted, beginning with the smallest position displacement of 0.1% and continuing until a significant difference was reached. Additionally, the mean of the confidence ratings was calculated for each position displacement and then analyzed with planned comparisons (i.e. paired-samples *t*-Tests) against the zero-displacement condition in the same way it was done with the probability of the right side. According to previous research (e.g., Masters et al., 2007), the off-center effect exists for displacements of the goalkeeper at which participants choose the bigger side of the goal more often though confidence scores do not differ from trials in which the goalkeeper is indeed placed in the true center of the goal.

For the data of the *goalkeeper-related instruction condition*, a preliminary inspection revealed that the number of decisions to kick (because participants perceived the goalkeeper standing in the middle of the goal) dropped significantly the more the goalkeeper was displaced from the middle of the goal (see Fig. 2), which was further confirmed by a one-way ANOVA on the factor "displacement" [*F*



Fig. 1. Depicted are five of fifteen stimulus displays used in the present study. The goalkeeper was shown in a neutral goalkeeping posture, either in the goal's center or in one of seven displacements (from top to bottom: 0.1%, 0.2%, 0.4%, 0.8%, 1.6%, 3.2%, and 6.4%, respectively) to the left (not displayed here) or right of center.

(1) = 273.822; $p < .001$]. Post-hoc pairwise comparisons yielded significant differences between the position displacements of 0.4% and 0.8%, 0.8% and 1.6%, 1.6% and 3.2% (all p 's < 0.05 , Bonferroni adjustments used to account for multiple comparisons).

Because of the small number of trials remaining in the 3.2% and the 6.4% displacement condition in which participants decided to kick, these positions were excluded from further analysis. Otherwise, the data to examine the goal-side selection was processed in the same way as for the goal-side-related direction of attention condition, with the exception that this time, only trials in which the participants perceived the goalkeeper in the middle of the goal were analyzed, and thus, were not aware of the displacement. Because penalty takers were asked to only decide for a goal side if they perceived the goalkeeper right in the center of the goal, it is usually assumed that penalty takers are influenced implicitly if they choose the bigger goal side more often.

In addition to these analyses that resemble approaches in previous research, we also tried to compare lower and higher thresholds

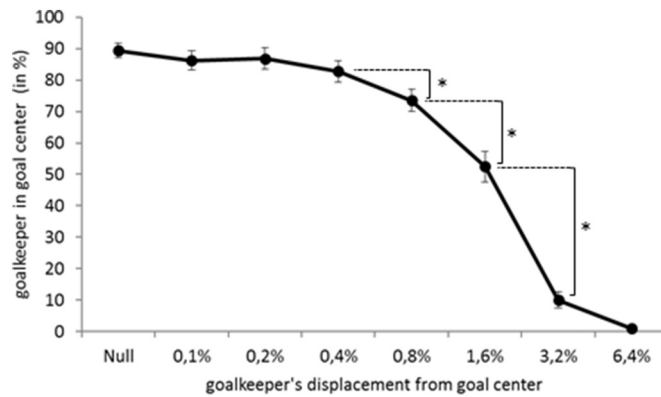


Fig. 2. Displayed is the percentage of trials in which participants (consciously) perceived the goalkeeper in the middle of the goal as a function of goalkeeper displacement from goal center under the goalkeeper-related instruction condition. Error bars indicate between-participant standard error. Stars yield significant differences between two adjacent goalkeeper displacements.

demarcating implicit perception from no perception and explicit perception respectively (i.e. the lower and higher end of goalkeeper displacement for which the off-center effect arises) more directly. Therefore, we determined the extent of the off-center effect for every participant in each condition. For the goal-side-related instruction condition, the off-center effect was assumed to occur as long as a participant chose the bigger side at least in 50% of all relevant trials (based on the size of the effect in previous studies) without being considerably more confident in their perceptual judgment (i.e. confidence levels differed less than 1 point on the 7-point-Likert-scale from trials in which the goalkeeper was indeed placed in the true center of the goal). For the goalkeeper-related instruction condition, the off-center effect was assumed to occur when participants decided to kick more often than 66% of all trials at a certain goalkeeper displacement while choosing the bigger goal side more often (see goal-side-related instruction condition). This procedure allowed us to test the influence of different directions of attention on individual extents of the off-center effect by means of a 2 (both types of direction of attention) \times 2 (lower t vs. higher threshold) ANOVA with repeated measures on both factors and the relative displacement of the goalkeeper as the dependent variable.

2. Results

2.1. Goal-side-related instructional focus

When the goalkeeper was not displaced and presented in the exact middle of the goal, the right goal side (57.1% of the trials) was selected more often as the greater goal side than the left goal side (42.9% of the trials). Accordingly, participants showed a goal-side selection bias for the right goal side, “bisecting” the goal line more to the left. This difference was statistically significant, $t(33) = 2.278$; $p < .05$.

The participant's goal-side selections in which the goalkeeper was displaced along the goal line are shown in Fig. 3. The mean percentages of selecting the greater goal side for the different displacements were 57.8%, 63.4%, 66.9%, 83.8%, 95.2%, 99.3%, and 99.7%, from smallest to largest. The planned comparison of the smallest displacement condition of 0.1% to chance level revealed a

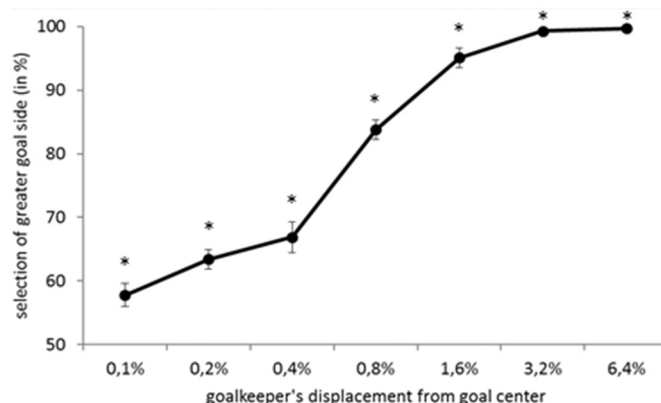


Fig. 3. Fig. 3 shows the selection of the greater goal side (in %) as a function of goalkeeper displacement from goal center under the goal-side-related instruction condition. Error bars indicate between-participant standard error. Stars yield significant differences in choosing the greater goal side from chance level.

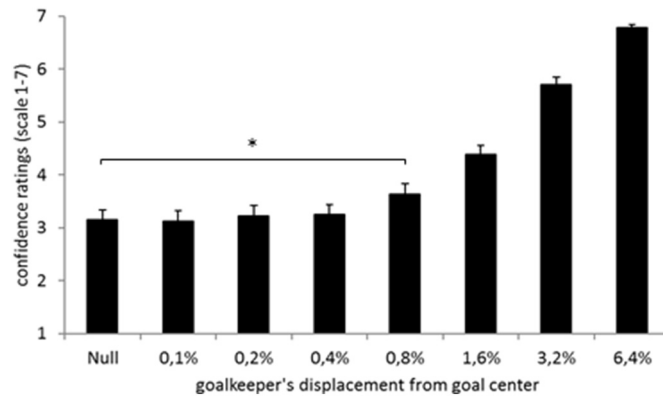


Fig. 4. Fig. 4 indicates the confidence of participants in their decision for the greater goal side on a scale from 1 to 7 as a function of goalkeeper displacement from goal center under the goal-side-related instruction condition. Error bars indicate between-participant standard error. The star signals the displacement condition in which participants became aware of the goalkeeper's displacement.

significant difference, $t(33) = 4.376$; $p > .001$, indicating that participants were able to select the larger goal side even with this minimal displacement (and as logically follows, for all other displacements). The confidence ratings are presented in Fig. 4. When the goalkeeper was not displaced and shown in the exact middle of the goal, the participant's confidence rating received a mean value of 3.2. For the different position displacements, the mean values were 3.1 (0.1%), 3.2 (0.2%), 3.3 (0.4%), 3.6 (0.8%), 4.4 (1.6%), 5.7 (3.2%), and 6.8 (6.4%), respectively. The planned comparisons for the position displacements from 0.1% to 0.4% were not significant, suggesting that participants were not aware of the displacement. At the 0.8% threshold, a significant difference to the neutral position was revealed, $t(33) = 7.053$, $p < .001$, indicating that participants became aware of the displacement.

2.2. Goalkeeper-related instructional focus

Although the left goal side was identified more often as larger across all trials (the probability was 50%), there was no significant difference found ($t(33) = 0.821$; $p > .05$).

Participant's goal-side selections under conditions in which they were not aware of the displacement along the goal line are shown in Fig. 5. The mean percentages of selecting the greater goal side for the different displacements from 0.1%, 0.2%, 0.4%, 0.8%, and 1.6% were 53.5%, 56.1%, 64.6%, 69.4%, and 80.9%, respectively. Goal-side selection for a 0.1% displacement was not significant and therefore considered to be by coincidence. The planned comparisons revealed a significant difference for the displacement of 0.2%, ($t(33) = 2.619$; $p < .05$), demonstrating that participants reliably selected the larger goal side with this displacement (and as logically follows, for all the bigger displacements). This was also the case for all the bigger displacements.

2.3. Comparing both direction of attention conditions

We also compared the results of both conditions more directly as a within-subject variable in a repeated measures ANOVA. As reflected by a significant interaction between instruction condition and type of threshold, $F(1, 33) = 19.65$, $p < .001$, $\eta_p^2 = 0.37$,

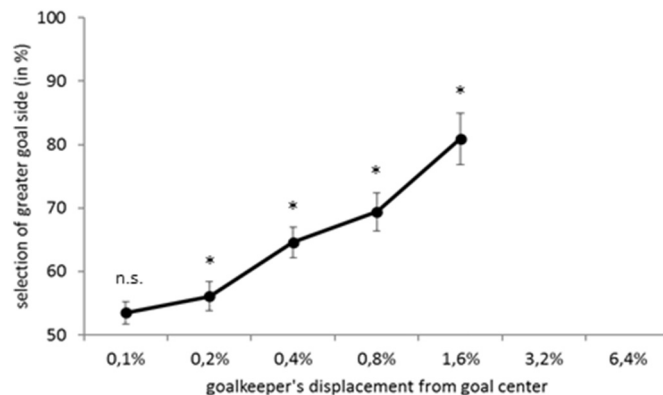


Fig. 5. Fig. 5 shows the selection of the greater goal side (in %) as a function of goalkeeper displacement from goal center under the goalkeeper-related instruction condition. Error bars indicate between-participant standard error. Stars yield significant differences in choosing the greater goal side from chance level. Please note, that data was only analyzed for displacements from 0.1% - 1.6%.

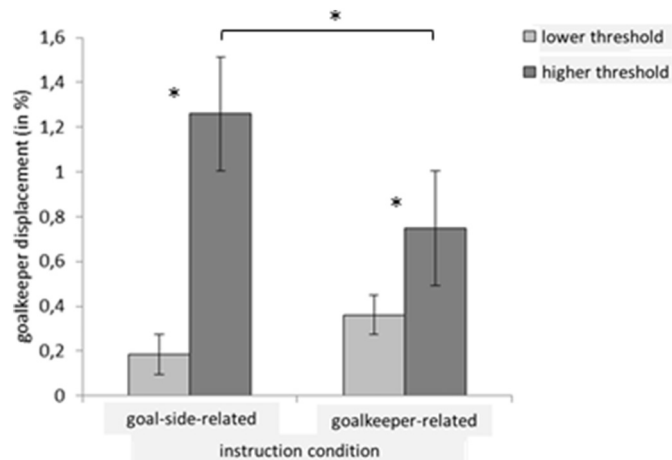


Fig. 6. Fig. 6 indicates the lower and higher thresholds demarcating implicit/no perception of the goalkeepers' displacement (lower threshold) as well as implicit/explicit perception of the goalkeepers' displacement relative to the position of the goalkeepers for both, the goal-side-related and the goalkeeper-related instruction condition. Error bars indicate standard errors. Stars yield significant differences between two thresholds.

the lower thresholds (the smallest displacement of the goalkeeper for which the off-center effect occurred) did not differ between the two conditions (0.19% vs. 0.36%), but the higher thresholds, signaling the smallest displacement for which participants became consciously aware) did (1.3% vs. 0.75%). Furthermore, the lower thresholds differed significantly from higher thresholds in both conditions, $F(1, 33) = 7.04$, $p < .02$, $\eta_p^2 = 0.18$, signaling that for both directions of attention there is a range of displacements for which the off-center effect occurred (Fig. 6).

3. Discussion

The present experiments aimed to examine the influence of different directions of attention on the extent of the off-center effect, which influences the penalty taker's perception and decision-making for choosing the goal side of the penalty kick. In a first step, we replicated previous findings using established ways of analyzing goal-side selection data to estimate the extent of the off-center effect (Noël et al., 2016; Noël, Furley, et al., 2015; Weigelt et al., 2012; Weigelt & Memmert, 2012). The off-center effect occurred, but lower and higher thresholds of the effects were not the same as when using established analyses, as will be discussed below.

In more detail, the results concerning the goal-side-related direction of attention confirm previous studies that demonstrated effects on goal-side selection in the off-center paradigm (Masters et al., 2007, Experiments 1 & 2; Weigelt & Memmert, 2012; Weigelt et al., 2012). Accordingly, participants were able to select the greater goal side even when they were not aware of the goalkeeper's displacement. Surprisingly, this was already the case when the goalkeeper was only displaced by 0.1%, which relates to 0.73 cm in a real soccer goal. Thus, a very small displacement was already large enough for information processing to surpass the lower threshold (demarcating implicit and no perception of the goalkeeper's position) and to influence the penalty taker's decision-making without penalty takers being aware of it. Participants became mindful of the displacement, when the goalkeeper's displacement was 0.8% (5.85 cm in a real size goal) and larger, as they indicated the goal side with greater confidence. This marks a higher threshold between implicit and explicit perception.

In the goalkeeper-related direction of attention, participants were instructed to only respond when they perceived the goalkeeper to be standing in the middle of the goal. They indicated the greater goal side at above-chance, however, for the displacement condition of 0.2%, which relates to 1.46 cm in the real soccer goal, resembling the lower threshold between implicit and explicit perception. At this point, participants were not aware of the displacement. They became aware when the goalkeeper was displaced by 0.8%, as the number of decisions to kick dropped significantly down to 73.5%. When the goalkeeper was displaced further along the goal line by 1.6% (11.71 cm in the real soccer goal), participants responded in only half of the trials (52.5%), and they were even more conscious in the 3.2% displacement condition (with only 10.0% responses). From this pattern of results, it can be inferred that the higher threshold between implicit and explicit perception is at goalkeeper's displacements of 0.8% and larger.

Comparing the higher and lower thresholds demarcating the range of goalkeeper displacements for which the off-center effect arises in both conditions showed that different directions of attention influence the percentage of displacement; i.e. the displacement from which participants become aware of the goalkeeper's true position. That is, penalty takers in both conditions were implicitly influenced by rather small and comparable displacements, but participants became aware of goalkeeper displacements earlier when attention was directed to the size of the goal sides as compared to the goalkeeper's position. Still, the (implicit) decisions for the bigger goal side did not differ significantly for the range of displacements participants were not aware of. It seems questionable how existing models of unconscious perception can explain the full pattern of results. Attention directed to or away from the critical stimulus (position and displacement of the goalkeeper) could certainly be a factor influencing how strong a stimulus must be to get access to consciousness (e.g., Dehaene et al., 2006; see Noël et al., 2016). However, this should also affect the required size of a displacement to affect behavior or decision-making implicitly. That is, at this point, it is rather unclear why different directions of

attention should influence higher thresholds without influencing lower thresholds of the off-center effect. Admittedly, the results could be slightly different if the values we used to define the extent of the off-center effect for every participant were changed. The values used in the current study can be considered conservative and were chosen to prevent overestimation of the off-center effect's extent. Regarding this, it is important to note that though data analyses were modified, the off-center effect could still be reported. Taken together, the stability of the effect across different directions of attention and ways of analyses supports the previous findings that small displacements of the goalkeeper influence decision-making in soccer penalty kicking implicitly (e.g., Masters et al., 2007; Noël, van der Kamp, et al., 2015; Weigelt et al., 2012; Weigelt & Memmert, 2012).

Certainly, our experiment is not free of limitations. Since we have tested the scenarios on a computer screen, the results may differ under real-life conditions. Just to note, Noël, Furley, et al. (2015) have already demonstrated the main off-center effect using a real-life representative setting, with perception-action-coupling of the striker. Therefore, this effect can be generalized from the laboratory environment to the soccer field. Nevertheless, a generalization of results of laboratory studies to performance environments is not trivial. Perceptual expertise is one measure of behavior that particularly influences these kinds of tasks and was shown to differ between laboratory studies and natural experimental settings (Mann, Williams, Ward, & Janelle, 2007), i.e. a real opponent stimulates more accurate movement responses in expert tennis players than a video of an opponent (Shim, Carlton, & Kwon, 2006). More research on how perceptual-motor behaviors in representative experimental conditions allow appropriate generalization of conclusions to performance environments is needed to solve this discrepancy (Dicks, Button, & Davids, 2010). Surely, the perception of the strikers may be different when it comes to a real-life situation. Therefore, we recommend future studies with a higher ecological validity (e. g., VR-environment).

Nevertheless, some practical implications for goalkeepers and strikers could be discussed based on our findings. Coaches could utilize particular instructional methods in their training to guide the attention of the players to different locations. Goalkeepers could consider positioning themselves slightly off-center, to implicitly influence the penalty kickers' decisions. Penalty takers should avoid paying attention to the goalkeeper. In line with Bakker et al. (2006), Furley, Noël, and Memmert, 2016 as well as Wilson et al. (2007), it is better to choose a goal side before shooting and not to pay much attention to the goalkeeper. Further strategies for striker and goalkeepers are discussed elsewhere (for a review, Memmert et al., 2013).

To sum up, the current study shed more light on the extent of the off-center effect by using fine-grained stimuli and by adding a direct comparison of the influence of different directions of attention (previously used in research on the effect) on the range of goalkeeper displacements for which penalty takers' decision-making seems to be influenced implicitly.

Author statement

DMe and MW developed the study concept in collaboration with BN and JK. Data collection was performed by MW with the help of DMe and MW performed the data analyses. All authors contributed to the interpretation of the results. DMe and MW drafted the manuscript, and BN and JV provided critical revisions. All authors approved the final version of the manuscript for submission.

Acknowledgments

This research was supported by a grant from the German Research Council (DFG, Deutsche Forschungsgemeinschaft) to the first (ME 2678/14-1), fourth, and last author (WE 2800/8-1).

References

- Bakker, F. C., Oudejans, R. D., Binsch, O., & van der Kamp, J. (2006). Penalty taking & gaze behavior: Unwanted effects of the wish not to miss. *International Journal of Sport Psychology*, 37, 265–280.
- Binsch, O., Oudejans, R. D., Bakker, F. C., & Savelsbergh, G. J. P. (2010). Ironic effects and final target fixation in a penalty shooting task. *Human Movement Science*, 29, 277–288.
- Dehaene, S., Changeaux, J. P., Naccache, L., Sackur, J., & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: A testable taxonomy. *Trends in Cognitive Sciences*, 10, 204–211.
- Dicks, M., Button, C., & Davids, K. (2010). Examination of gaze behaviors under in situ and video simulation task constraints reveals differences in information pickup for perception and action. *Attention, Perception, & Psychophysics*, 72, 706–720.
- Fiedler, K. (2011). Voodoo correlations are everywhere—not only in neuroscience. *Perspectives on psychological science*, 6(2), 163–171.
- Furley, P., Noël, B., & Memmert, D. (2017). Attention towards the goalkeeper and distraction during penalty shootouts in association football: A retrospective analysis of penalty shootouts from 1984 to 2012. *Journal of Sports Sciences*, 35(9), 873–879.
- Harle, S. K., & Vickers, J. N. (2001). Training quiet eye improves accuracy in the basketball free throw. *The Sport Psychologist*, 15, 289–305.
- Mann, D. Y., Williams, A., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457–478.
- Masters, R. S. W., van der Kamp, J., & Jackson, R. C. (2007). Imperceptible off-center goalkeepers influence penalty-kick direction in soccer. *Psychological Science*, 18, 222–223.
- Memmert, D., Hüttermann, S., Hagemann, N., Löffing, F., & Strauß, B. (2013). Dueling in the penalty box: Evidence-based recommendations on how shooters and goalkeepers can win penalty shootouts in soccer. *International Review of Sport and Exercise Psychology*, 6, 209–229.
- Noël, B., Furley, P., van der Kamp, J., Dicks, M., & Memmert, D. (2015). The development of a method for identifying penalty kick strategies in association football. *Journal of Sports Sciences*, 33, 1–10.
- Noël, B., Hüttermann, S., van der Kamp, J., & Memmert, D. (2016). Courting on the beach: How team position implicitly influences decision-making in beach volleyball serves. *Journal of Cognitive Psychology*, 1–9. <https://doi.org/10.1080/20445911.2016.1194847>.
- Noël, B., & van der Kamp, J. (2006). Gaze behaviour during the soccer penalty kick: An investigation of the effects of strategy and anxiety. *International Journal of Sport Psychology*, 43, 326–345.
- Noël, B., & van der Kamp, J. (2012). Gaze behaviour during the soccer penalty kick: An investigation of the effects of strategy and anxiety. *International Journal of Sport*

- Psychology*, 43, 326–345.
- Noël, B., van der Kamp, J., Weigelt, M., & Memmert, D. (2015). Asymmetries in spatial perception are more prevalent under explicit than implicit attention. *Consciousness and Cognition*, 34, 10–15.
- Shim, J., Carlton, L. G., & Kwon, Y. H. (2006). Perception of kinematic characteristics of tennis strokes for anticipating stroke type and direction. *Research Quarterly for Exercise and Sport*, 77(3), 326–339.
- Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological science*, 22(11), 1359–1366.
- Vickers, J. N. (2012). Neuroscience of the quiet eye in golf putting. *International Journal of Golf Science*, 1, 2–9.
- Weigelt, M., & Memmert, D. (2012). Goal-side selection in soccer penalty kicking when viewing natural scenes. *Frontiers in Psychology*, 3 Article 312.
- Weigelt, M., Memmert, D., & Schack, T. (2012). Kick it like Ballack: The effects of goalkeeping gestures on goal-side selection in experienced soccer players and soccer novices. *Journal of Cognitive Psychology*, 24, 942–956.
- Wilson, M. R., Chattington, M., Marple-Horvat, D. E., & Smith, N. C. (2007). A comparison of self-focus versus attentional explanations of choking. *Journal of Sport & Exercise Psychology*, 29, 439–456.
- Wood, G., & Wilson, M. R. (2011). Quiet-eye training for soccer penalty kicks. *Cognitive Processing*, 12, 257–266.
- Wood, G., & Wilson, M. R. (2012). Quiet-eye training, perceived control and performing under pressure. *Psychology of Sport & Exercise*, 13, 721–728.